FOURTH REPORT ON THE COLLEGE ENTRANCE COURSE IN BOTANY

FORMULATED BY A COMMITTEE OF THE SOCIETY FOR PLANT MORPHOLOGY AND PHYSIOLOGY, NOW THE COMMITTEE ON EDUCATION OF THE BOTANICAL SOCIETY OF AMERICA[1]

FOREWORD

At its meeting, December 28, 1900, the Society for Plant Morphology and Physiology, in the belief that education in its specialty should be a chief care of any scientific society, and in the knowledge that an authoritatively formulated high-school course in botany suitable for entrance to college would be acceptable to the College Entrance Examination Board, appointed a committee to formulate such a course. The committee outlined a course which it sent in printed form, in April, 1901, to members of the society and to prominent teachers of botany throughout the country. On this basis, and taking account of the information, suggestions, and criticisms received, the committee printed, in September, 1901, a revised course which was offered to the College Entrance Examination Board and accepted in December, 1901. It was published by the Board in its Official Document, No. 8, issued January 10, 1902, and examinations were held thereon in June, 1902, and have been held every year since then. This course, with a statement of the principles involved in its formulation, was printed (in *School Science*) as the Third Report of the committee in May, 1902, which report, in reprinted form, has been very widely circulated. The committee was continued in charge of the course, and, on the basis of additional experience and new information, recommended to the society, at its meeting in December, 1905, certain changes in the direction of simplification and clarification. These changes were approved by the society, were accepted by the College Entrance

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Examination Board and are incorporated in the course as printed in its Official Document, No. 35, of December 1, 1907. On the merging of the botanical societies, the committee became a committee of the Botanical Society of America; and on December 31, 1907, it was made a standing Committee on Education, constituted as undersigned, and was instructed to prepare the present Report.

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A SPECIAL RECOMMENDATION CONCERNING THE COURSE

In authorizing the publication of the present Report, the Botanical Society of America voted the following recommendation:

That all members of this society who are connected with universities or colleges be requested to bring before their respective faculties the fact that examinations are now being held every June, by the College Entrance Examination Board, in all the principal centers of the country, in a year's thorough course in botany, a course ample to count as 1 point out of 14 or 15 for entrance, that such a course is already accepted as an entrance option in some colleges, and that it is desirable for the sake of the progress of the science, for the sake of the schools, and for the sake of the colleges that it be widely, or indeed universally, accepted by colleges as an option for entrance.

The committee will venture to add that in spirit this recommendation is addressed to every college teacher of botany and to every college in the country. And if any explanation of the advantage to the science is needed, it will be found in the simple fact that under present educational conditions it is practically impossible for any subject to receive suitable consideration in the three upper years of most high schools unless it can be counted for entrance to college.

PRINCIPLES UPON WHICH THE COURSE IS FORMULATED

1. It is founded upon the two important Reports of the National Educational Association—the "Report of the Committee of Ten" (Washington, 1893), and the Report on College Entrance Requirements (Chicago, 1899). These have been modified in accord with the results of more recent experience, and the advice of leading teachers.

2. While intended primarily as an option for entrance to college, it is designed equally for the education in the high school of the general student who can follow the subject no farther; there are in botany no advantages in having the college preparatory and the general educational courses different, at least none that are at all commensurate with the additional burden thus laid upon the schools.

3. It is designed to yield a mental discipline fully equal in quality and quantity to that yielded by any other subject studied for the same length of time.

4. It should, if possible, have as a foundation a considerable body of botanical fact learned through nature-study in the lower schools; it should be given in one of the three upper years as part of a four years' high-school course in the sciences; it should be considered and treated as an elementary or preliminary course leading to second courses in college, and colleges accepting the option should arrange second courses to articulate economically with it.

5. The immediate plan of its construction is very simple, namely, to include those topics in the leading divisions of the subject which most teachers now regard as fundamental, whether for their value in scientific training, or as knowledge; but the individual teacher is left free to follow his own judgment as to sequence of topics, text and other books, and special methods. Advice is occasionally offered, however, upon important points in which most teachers are now known to agree.

6. It recognizes the existence of, and provides for, two modes of procedure in the sequence of topics. In one, which is that strongly advised by the committee, the general facts of plant structure and function, permitting a beginning with large and familiar objects and phenomena, are first studied, to be followed later by a study of representatives of the groups of plants from the lower to the higher; in the other the study of the groups is the backbone, as it were, of the course, which begins with the lowest forms and introduces the physiological and morphological topics at appropriate places in the ascending series. The two modes, however, lead to substantially the same result, and a common examination is practicable for both.

7. The amount of work in the course is designed to occupy a year of five periods a week under good conditions. Where special circumstances, such as exceptional difficulty of obtaining material, etc., prevent the completion of the entire amount while allowing its equivalent in thoroughness, it is recommended that some of the minor topics here and there be omitted rather than that the attempt be made to cover all superficially. To provide for this possibility the examination papers should always include a number of alternative questions.

8. The time per week, inclusive of recitation, preparation, and laboratory should be the same as for any other subject. Where five periods a week,

with an hour of preparation for each, are demanded for other studies, this course should receive the equivalent of two recitation periods with their preparation, together with three double (not six separated) periods in the laboratory. Variation from this should be towards a greater, not a lesser proportion of laboratory work. The preparation of records of the laboratory work, in which stress is laid upon diagrammatically accurate drawing and precise and expressive description, should be regarded as an integral part of the course; and these records, preferably in a notebook, should be counted at least one-third towards the students' standing.

9. The course is arranged in two parts, each occupying a half-year and complete in itself. This is in part to accord with principle 6, preceding, and in part to allow either a combination of a half year of botany with a half year of zoölogy to form a year's course in biology, or else to provide a shorter course as needed in some schools. In any case a half-year course in botany should consist of Part I or Part II, never of a combination of both, a recommendation based partially upon educational principle and partly upon the practical difficulty of providing examinations and articulating later college courses with such diverse combinations.

10. The course is intended to be relatively permanent, yet is modifiable in adaptation to changing educational conditions and the approved results of experience. Changes will not, however, be made for some time, and not until announced in a fifth edition of this report. The committee will welcome all suggestions and criticisms.

SPECIFICATIONS OF THE TOPICS TO BE STUDIED

PART I. THE GENERAL PRINCIPLES OF (A) ANATOMY AND MORPHOLOGY, (B) PHYSIOLOGY AND ECOLOGY

A. ANATOMY AND MORPHOLOGY.

The Seed. Four types (dicotyledon without and with endosperm, a monocotyledon and a gymnosperm); structure and homologous parts. Food supply; experimental determination of its nature and value. Phenomena of germination and growth of embryo into a seedling, (including bursting from the seed, assumption of position and unfolding of parts).

The Shoot. Gross anatomy of a typical shoot; including the relationships of position of leaf, stem (and root), the arrangement of leaves and buds on the stem, and deviations (through light adjustment, etc.) from symmetry. Buds, and the mode of origin of new leaf and stem; winter buds in particular. Specialized and metamorphosed shoots (stems and leaves). General structure and distribution of the leading tissues of the shoot; annual growth; shedding of bark and leaves.

The Root. Gross anatomy of a typical root; position and origin of secondary roots; hair-zone, cap and growing-point. Specialized and

metamorphosed roots. General structure and distribution of the leading tissues of the root.

The Flower. Structure of a typical flower, especially of ovule and pollen; functions of the parts. Comparative morphological study of four or more different marked types, with the construction of transverse and longitudinal diagrams.

The Fruit. Structure of a typical fruit. Comparative morphological study of four or more marked types with diagrams.

This comparative morphological study of flowers and fruits may advantageously be postponed to the end of II, and then taken up in connection with classification of the Angiosperms.

The Cell. Cytoplasm, nucleus, sap-cavity, wall.

As to the study of the cell, it is by no means to be postponed for consideration by itself after the other topics, as its position in the above outline may seem to imply, but it is to be brought in earlier, along with the study of the shoot or root, and continued from topic to topic. Although enough study of the individual cell is to be made to give an idea of its structure (a study which may very advantageously be associated with the physiological topics mentioned first under B), the principal microscopical work should consist in the recognition and study of the distribution of the leading tissues.

B. PHYSIOLOGY AND ECOLOGY.

Rôle of water in the plant; *absorption* (*osmosis*), *path of transfer, transpiration, turgidity and its mechanical value, plasmolysis.*

Photosynthesis; *Dependence of starch formation upon chlorophyl, light and carbon dioxide; evolution of oxygen,* observation of starch grains.

Respiration; *need of oxygen in growth, evolution of carbon dioxide.*

Digestion; *Digestion of starch with diastase,* and its rôle in translocation of foods.

Irritability; *Geotropism, heliotropism* and *hydrotropism.*

Growth; *localization in higher plants; amount in elongating stems; relationships to temperature.*

Fertilization; sexual and vegetative reproduction.

Although for convenience of reference, the physiological topics are here grouped together, they should by no means be studied by themselves and apart from anatomy and morphology. On the contrary, they should be taken up along with the study of the structures in which the processes occur, and which they help to explain; thus,—photosynthesis should be studied with the leaf, as should also transpiration, while digestion may best come with germination, osmotic absorption with the root, and so on. The student should either try, or at least aid in trying, experiments to demonstrate the fundamental processes indicated above in italics.

Modifications (metamorphoses) of parts for special functions.

Dissemination. Cross-pollination.

Light relations of green tissues; leaf mosaics.

Special habitats; Mesophytes, Hydrophytes, Halophytes, Xerophytes; Climbers, Epiphytes, Parasites (and Saprophytes), Insectivora.

The topics in ecology (particularly the first four and in part the fifth), like those in physiology, are to be studied not by themselves, but along with the structures with which they are most closely associated, as cross-pollination with the flower, dissemination with the seed, etc. The fifth may most advantageously be studied with G in Part II.

In this connection field-work is of great importance, and, for some topics, is indispensable, though much may be done also with potted plants in greenhouses, photographs, and museum specimens. It is strongly recommended that some systematic field-work be considered as an integral part of the course, co-ordinate in definiteness and value as far as it goes with the laboratory work. The temptations to haziness and guessing in ecology must be combated.

PART II. THE NATURAL HISTORY OF THE PLANT GROUPS, AND CLASSIFICATION

A comprehensive summary of the great natural groups of plants, based upon the thorough study of the structure, reproduction and adaptations to habitat of one or two types from each group, supplemented and extended by more rapid study of other forms in those groups. Where living material is wanting for the latter, preserved material and even good pictures may be used, and a standard textbook should be thoroughly read. The general homologies from group to group should be understood, though it is not expected that these will be known in detail.

In general, in this part of the course, it is recommended that much less attention be given to the lower and inconspicuous groups, and progressively more to the higher and conspicuous forms.

Following is a list of recommended types from which, or their equivalents, selection may be made:

A. ALGAE. Pleurococcus. Sphaerella, Spirogyra, Vaucheria, Fucus, Nemalion (or Polysiphonia or Coleochaete).

B. FUNGI. Bacteria, Rhizopus or Mucor, Yeast, Puccinia (or a powdery mildew), Corn Smut, Mushroom.

Bacteria and yeast have obvious disadvantages in such a course, but their great economic prominence may justify their introduction.

C. LICHENS. Physcia (or Parmelia, or Usnea).

D. BRYOPHYTES. In Hepaticae, Radula (or Porella or Marchantia). In Musci, Mnium (or Polytrichum or Funaria).

E. PTERIDOPHYTES. In Filicineae, Aspidium or equivalent, including, of course, the prothallus.
In Equisetineae, Equisetum.
In Lycopodineae, Lycopodium and Selaginella (or Isoetes).

F. GYMNOSPERMS. Pinus or equivalent.

G. ANGIOSPERMS. A monocotyledon and a dicotyledon, to be studied with reference to the homologies of their parts with those in the above groups; together with representative plants of the leading subdivisions and principal families of Angiosperms.

Classification should include a study of the primary subdivisions of the above groups, based on the comparison of the types with other living (preferably) or preserved material. The principal subdivisions of the Angiosperms, grouped on the Engler and Prantl system, should be understood.

The ability to use manuals for the determination of the species of flowering plants is not considered essential in this course, though it is most desirable. It should not be introduced to the exclusion of any part of the course, but should be made voluntary work for those showing a taste for it. It should not be limited to learning names of plants, but should be made a study in the plan of classification as well.

The preparation of an herbarium is not required nor recommended except as voluntary work for those with a taste for collecting. If made, it should not represent so much a simple accumulation of species as some distinct idea of plant associations, or of morphology, or of representation of the groups, etc.